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Ichneumonid parasitoids of *Tortrix viridana* (Lepidoptera, Tortricidae) in the west of Iran

Abbas MOHAMMADI-KHORAMABADI, Salah-Aldin KAMANGAR & Hosseinali LOTFALIZADEH

A b s t r a c t : This study was conducted to identify the Ichneumonidae parasitoids of *Tortrix viridana* (Lep.: Tortricidae) on oak trees in the west of Iran from 2012 to 2013. Larvae and pupae of *T. viridana* was collected and reared under room conditions. Four parasitoids of the family Ichneumonidae were reared and identified. Of them, three species which marked with an asterisk are newly recorded from Iran: *Diadegma longicaudatum** (Campopleginae), *Lissonota palpalis** (Banchinae), *Scambus elegans** (Pimplinae) and *Temelucha lucida* (Cremastinae). Their taxonomy, distribution and hosts were discussed.

K e y w o r d s : *Tortrix viridana*, Ichneumonidae, new record, Iran.

Introduction

The oak leaf roller moth, *Tortrix viridana* (LINNAEUS, 1758) is the most serious pest of the oak trees in the western Palaearctic (COLE 1967; GHOBARI et al. 2007; HORSTMANN 1984). The moth takes one generation a year and passes most of the year from July to March in the egg developmental stage. The larvae of the moth feed on buds and leaves of the oak trees and in high populations can completely defoliate their tree host. This pest distributed in the north (Hyrcanian forests, Mazandaran province) and the west (Zagros forests, Chaharmahal & Bakhtiari, Fars, Kohkilouyeh & Bouyer Ahmad and Kurdistan provinces) of Iran (ASKARY et al. 2005; GHOBARI et al. 2007).

In the biological control approach of *T. viridana*, there have been known a large number of dipteran and hymenopterous chalcidoid and ichneumonoid parasitoids on this pest (BOGENSCHUTZ 1964; COLE 1967; HORSTMANN 1970; HORSTMANN 1984; YU et al. 2012). HORSTMANN (1984) studied the population dynamics of *T. viridana* in Germany and reared 26 species of primary and 9 secondary parasitoids from it. TOLKANITZ & SEREGINA (1988) identified and presented a key to 34 Ichneumonid parasitoids of *T. viridana* in the Ukraine. There have been yet listed 101 Ichneumonid species into 11 subfamilies associated with *T. viridana* in the world (YU et al. 2012).

In Iran, *Quercus branti* and *Q. infectoria* are the main oak tree species of Zagros forests with the area of more than five million hectare and Kurdistan province comprises about 500,000 hectare of these oak forests (JAZIREHI & EBRAHIMI-ROSTAGHI 2003). The aim of

this study was to rear and identify the ichneumonid parasitoids of the oak leaf roller in Kurdistan province, west of Iran.

Material and Methods

The study was carried out in Marivan (Galeji Village (N= 35° 22′ E= 46° 16′, 1264 m a.s.l.) and Colit (N= 35° 41′ E= 46° 18′, 1569 m a.s.l.)) and Baneh (N= 36° 08′ E= 45° 02′, 1450 m a.s.l.) counties of Kurdistan province, Iran during 2012- 2013. Based on the biology of *T. viridana* (ASKARY et al. 2005; GHOBARI et al. 2007; HORSTMANN 1984), five samples of 100 larvae and pupae of *T. viridana* were randomly taken from April to June 2012-2013 by the interval of 7-10 days in each of the three abovementioned localities. They then were transferred to the laboratory and reared under room conditions, fed with fresh leaves of oak trees and were observed daily until adults of the moth and/or its parasitoids appeared. The collected ichneumonids were identified using keys provided by KASPARYAN (1981).

Results

A total of 17 specimens of the family Ichneumonidae were reared and collected on *T. viridana* during 2012-1013. They represented four species belong to four subfamilies. Three species of them are recorded for the first time from Iran which are marked with an asterisk.

Family Ichneumonidae

Subfamily B a n c h i n a e

***Lissonota palpalis* THOMSON, 1889**

M a t e r i a l e x a m i n e d : IRAN, Kurdistan, Baneh (N= 36° 08′ E= 45° 02′, 1450 m a.s.l.), 1♀, 11.5.2013, ex. larva of *T. viridana*, Leg. S. Kamangar.

G e n e r a l d i s t r i b u t i o n : Czechoslovakia, France, Germany, Hungary, Ireland, Moldova, The Netherlands, Poland, Romania, Sweden, United Kingdom (YU et al. 2012) and Iran (new record).

D i a g n o s t i c c h a r a c t e r s : Pronotum with yellow stripes; ovipositor length equal to Metasoma; fore wing without an areolet; body with abundant red pattern; claws simple; frons flat; vertex normal, without carinae or striations (KASPARYAN 1981).

H o s t s : *Ypsolopha parenthesella* (LINNAEUS, 1761) (Lep.: Ypsolophidae), *Thaumetopoea processionea* (LINNAEUS, 1758) (Lep.: Thaumetopoeidae) (YU et al. 2012) and *T. viridana* (new host record).

R e m a r k : *Lissonota palpalis* was a primary solitary larval koinobiont endoparasitoid of *T. viridana*.

Subfamily C a m p o p l e g i n a e

***Diadegma longicaudatum* HORSTMANN, 1969**

M a t e r i a l e x a m i n e d : IRAN, Kurdistan province, Baneh (N= 36° 08′ E= 45° 02′, 1450 m a.s.l.), 1♂1♀, 11.5.2013, ex. larvae of *T. viridana*; Marivan, Colit (N= 35° 41′ E= 46° 18′, 1569 m a.s.l.), 1♀, 18.5.2013, ex. pupa of *T. viridana* Leg. S. Kamangar.

G e n e r a l d i s t r i b u t i o n : Austria, Bulgaria, Czech Republic, France, Germany, Poland, Romania (YU et al. 2012) and Iran (new record).

D i a g n o s t i c c h a r a c t e r s : Posterior margin of 7th tergite of metasoma barely cut; ovipositor sheath longer than the first metasomal segment and also the hind tibia; head and metasoma without yellow patterns; hind coxa black; fore wing with areolet; head strongly narrowed posteriorly; areola of propodeum with parallel side edges; main segments of flagellum black; hind tibia distinctly black with a white band in the middle and base; femura red; palps, mandibles and tegulae yellow (KASPARYAN 1981).

H o s t s : PISICA (2005) reared *D. longicaudatum* on *T. viridana* in Romania. *Trichopsyche fusca* (HAWORTH, 1809) and *Bijugis silvicolella* SIEDERB. (Lep.: Psychidae); *Lobesia* (*Polychrosis*) *botrana* (DENIS & SCHIFFERMÜLLER, 1775) (Lep.: Tortricidae); *Plutella xylostella* (LINNAEUS, 1758) (Lep.: Plutellidae) are known as other hosts of this species (YU et al. 2012).

R e m a r k s : *Diadegma longicaudatum* was a primary, solitary koinobiont endoparasitoid of *T. viridana*. This species was a larva-pupal parasitoid.

Subfamily C r e m a s t i n a e

***Temelucha lucida* (SZEPLIGETI, 1899)**

M a t e r i a l e x a m i n e d : IRAN, Kurdistan province, Marivan, Colit (N= 35° 41′ E= 46° 18′, 1569 m a.s.l.), 1♀, 30.4.2013, ex. last instar larva of *T. viridana*, 1♂, 9.5.2012, ex. last instar larva of *T. viridana*, 1♀, 10.5.2013, ex. last instar larva of *T. viridana*, 1♀, 16.5.2012, ex. pupa of *T. viridana*, 2♀, 26.5.2013, ex. pupae of *T. viridana*, Ghaleji Village (N= 35° 22′ E= 46° 16′, 1264 m a.s.l.), 1♀, 24.5.2012, ex. pupa of *T. viridana*, leg. S. Kamangar.

G e n e r a l d i s t r i b u t i o n : Bulgaria, Czechoslovakia, Greece, Hungary, Italy, Moldova, Romania, Russia, Russia-Altayskiy Kray, Russia-Dagestanskaya Respublika, Turkey (YU et al. 2012) and Iran (Fars and west Azarbaijan provinces) (GHAHARI & JUSSILA 2011c).

D i a g n o s t i c c h a r a c t e r s : *Temelucha lucida* can be distinguished from other species of this genus by a combination of the following characters: Body mostly black with abundant red pattern; lower margin of clypeus convex; head distinctly narrow posteriorly; clypeus moderately convex; scutellum partly yellow; propodeum short, convex laterally; mesoscutum densely and coarsely punctured; notauli absent; metasoma black with 1st -2nd tergite medially red; other tergites laterally yellow-red; ocelli small; ovipositor tip not curved; ovipositor as long as fore wing (KASPARYAN 1981).

H o s t s : *Isauria dilucidella* DUPONCHEL 1836 (Lep.: Pyralidae), *Rhyacionia buoliana* (DENIS & SCHIFFERMÜLLER 1775) (Lep.: Tortricidae) (YU et al. 2012) and *T. viridana* (new host record).

Remarks: *Temelucha lucida* was a primary, solitary koinobiont endoparasitoid of *T. viridana*. Larva of *T. lucida* developed into larva of *T. viridana* and then adult emerged from larva or pupa of its host.

Subfamily Pimplinae

***Scambus elegans* (WOLDSTEDT 1877)**

Material examined: IRAN, Kurdistan, Marivan, Colit (N= 35° 41′ E= 46° 18′, 1569 m a.s.l.), 1♀, 8.5.2013, ex. pupa of *T. viridana*, 1♀1♂, 26.5.2013, ex. pupae of *T. viridana*; Ghaleji Village (N= 35° 22′ E= 46° 16′, 1264 m a.s.l.), 1♀, 24.5.2012, ex. pupa of *T. viridana*, 1♀1♂, 8.5.2013, ex. pupae of *T. viridana*, 1♀, 18.5.2013, ex. pupa of *T. viridana*, Leg. S. Kamangar.

General distribution: Albania, Austria, Azerbaijan, Belgium, Bulgaria, Croatia, Czech Republic, Czechoslovakia, Egypt, France, Germany, Hungary, Ireland, Israel, Italy, Macedonia, Poland, Romania, Russia, Russia-Krasnodar Kray, Serbia & Montenegro, Spain, Turkey, Ukraine, United Kingdom, Yugoslavia (YU et al. 2012) and Iran (new record).

Diagnostic characters: Ovipositor slightly laterally compressed, its basal teeth on top of the bottom valve form an angle with the longitudinal axis of about 30°; ovipositor sheath as long as metasoma; hypopygium with large membranous area extending from the base almost to the hind Seg quarter; 5th tarsomere of hind legs shorter than 2nd tarsomere; hind tibia with a dark pattern on the top and the base; length of antenna approximately equal to fore wing; thorax with abundant red pattern, pronotum red; pterostigma yellow with dark edges; punctures on 6th metasomal tergite with sharp edges.

Hosts: There have been known 22 lepidopterous species as hosts of *S. elegans* which belong to the families Gelechidae, Tortricidae, Gracillariidae, Argirestiidae, Choreutidae, Lyonetidae, Pyralidae (YU et al. 2012). *T. viridana* is a new host record.

Remarks: *Scambus elegans* was known as a solitary idiobiont pupal ectoparasitoid of *T. viridana*.

Discussion

This study showed that four species from four subfamilies of the family Ichneumonidae parasitized larval and pupal stages of *T. viridana* on oak trees in Kordistan province, the west of Iran. With these records, the number of ichneumonid parasitoid wasps on this pest in the subfamilies Banchinae, Cremastinae and Pimplinae increased to 10 (into 3 genera), 3 (into 2 genera) and 27 (into 11 genera) species respectively (PISICA 2005, YU et al. 2012). The subfamily Pimplinae has the highest number of parasitoid species in the family Ichneumonidae on *T. viridana* (YU et al. 2012). It follows by the subfamilies Campopleginae, Ichneumoninae, Bnachinae, Cryptinae, Tryphoninae, Anomaloninae, Metopiinae, Cremastinae, Mesochorinae and Poemeniinae.

Lissonota palpalis (Banchinae) was the least abundant species in our ichneumonids collected. It was the fourth known parasitoid of the genus on *T. viridana*. Banchinae are known as primary koinobiont endoparasitoid of Lepidoptera. Some of them are among the prevalent and active biological control agents of forest pests (BENNETT 2008). The

genus *Lissonota* has 139 species in the western Palaearctic and is the most diverse genus in the subfamily Banchinae (YU et al. 2012). Now, 14 species of Banchinae which of them, nine species belong to the genus *Lissonota*, have been reported from Iran (BARAHOEI et al. 2012; HOOSHYAR et al. 2012).

Diadegma longicaudatum (Campopleginae) is the fourth species of the genus associated with *T. viridana*. *Diadegma* is a large genus of the subfamily Campopleginae with 132 species in the western Palaearctic (YU et al. 2012). Campopleginae are primary koinobiont endoparasitoids of Coleoptera, sawflies and mostly Lepidoptera (BENNETT 2008; QUICKE et al. 2009). This subfamily is one of the most diverse subfamilies parasitizing *T. viridan*. Twenty four species into six genera of the subfamily were known as parasitoids of *T. viridana* (YU et al. 2012). The Campopleginae and the genus *Diadegma* have introduced by 36 and 8 species respectively in Iran (BARAHOEI et al. 2012). From the known campoplegines parsitizing *T. viridana* (YU et al. 2012), two species, *Campoplex tumidulus* and *Enytus apostata*, were reported and reared from three important pests in Iran (Tab. 1) (AKBARZADEH-SHOUKAT 2012; KISHANI FARAHANI et al. 2010; TALEBI et al. 2006).

Temeluch lucida was one of the most abundant parasitoids of *T. viridana*. It represented the third species of the subfamily Cremastinae associated with the moth. *Temelucha* has 47 species in the western Palaearctic (YU et al. 2012). In Iran, twelve species of the genus *Temelucha*, have been yet recorded (BARAHOEI et al. 2012). Among the world parasitoids list of *T. viridana* in the subfamily Cremastinae (YU et al. 2012), two species of the genus *Pristomerus* have been recorded from Iran (Tab. 1), which of them *Pr. vulnerator* was determined as a larval parasitoid of *L. botrana* (AKBARZADEH-SHOUKAT 2012).

Scambus elegnas (Pimplinae) was known as the fifth species of the genus *Scambus* parasitizing *T. viridana*. This species was the most abundant parasitoids of *T. viridana* in this study. The genus *Scambus* represents by 28 species in the western Palaearctic (YU et al. 2012). Members of the subfamily Pimplinae with 27 species into 11 genera is the most diverse subfamily of Ichneumonidae containing parasitoids of *T. viridana* (YU et al. 2012). From the sixty reported species of Pimplinae from Iran (BARAHOEI et al. 2012; MASNADI-YAZDINEJAD & JUSSILA 2008; MOHAMMADI-KHORAMABADI 2013; MOHAMMADI-KHORAMABADI et al. 2013; MOHAMMADI-KHORAMABADI et al. 2014), fifteen species are in the world parasitoid list of *T. viridana*. The known hosts of them in Iran are shown in Tab. 1 (AKBARZADEH-SHOUKAT et al. 2008; BABAEI et al. 2012; KARIMPOUR & HORSTMANN 2007; LOTFALIZADEH et al. 2012; RADJABI 2011). As Pimplinae are usually polyphagous, it is possible to rear more pimplines on *T. viridana* in future studies or other parts of Iran.

Comparing with some studies, the ichneumonid parasitoid community on *T. viridana* in Kordistan province, Iran showed low species richness. HORSTMANN (1984) reared 18 species of Ichneumonidae, including primary and hyperparasitoids, over a period of 16 years in an oak forest in Franconia, Germany. TOLKANITZ & SEREGINA (1988) collected 34 ichneumon flies as parasitoids of *T. viridana* in the Ukraine during 1981-1985. So, longer and more intensive rearing of larvae and pupae of *T. viridana* on oak trees of Iran are needed to reveal almost complete relationships between parasitic wasps of Ichneumonidae and *T. viridana*.

The four ichneumonid collected in this study were primary parasitoid of *T. viridana*.

Several hyperparasitoids in the family Ichneumonidae belonging to the subfamilies Cryptinae (*Gelis* spp.), Pimplinae (*Itoplectis* spp.) and Mesochorinae (*Mesochorus* sp.), Braconidae and superfamily Chalcidoidea affect the population of primary ichneumonid parasitoids of *T. viridana* (COLE, 1967; HORSTMANN, 1984). At least two species of the genus *Gelis* and two species of the genus *Itoplectis* (*I. alternans* and *I. maculator*) reported from Iran, were known as facultative hyperparsitoid on *T. viridana* (Tab 1).

Scambus elegans has wider range of hosts than other reared parasitoids. Iranian recorded species of the subfamilies Campopleginae, Cremastinae, Cryptinae and Pimplinae in Tab. 1 are polyphagous but *Dirophanes invisor*, *Diadromus varicolor* (Ichneumoninae) and *Tryphon* (*Symboethus*) *heliophilus* (Tryphoninae) has 3-7 known hosts (YU et al. 2012).

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Zusammenfassung

Vorliegende Studie widmet sich den Parasitoiden (Ichneumonidae) der an Eiche lebenden Tortricidenart *Tortrix viridana* (Lep.: Tortricidae). Untersuchungsgebiet und -zeitraum sind der Westiran in den Jahren 2012 und 2013. Es gelang der Nachweis der vier Ichneumonidenarten *Diadegma longicaudatum** (Campopleginae), *Lissonota palpalis** (Banchinae), *Scambus elegans** (Pimplinae) und *Temelucha lucida* (Cremastinae), wobei drei Arten (mit * markiert) Erstnachweise für den Iran darstellen. Ergänzend werden Angaben zu Taxonomie, Verbreitung und Wirtsspektrum angeführt.

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Authors' addresses:

Dr. Abbas MOHAMMADI-KHORAMABADI
Department of Plant Production, College of Agriculture and Natural Resources of Darab, Shiraz University, Shiraz, Iran
E-mail: Mohamadk@Shirazu.ac.ir

Salah-aldin KAMANGAR
Department of Plant Protection, Kurdistan Agricultural and Natural Resources Research and Education Center, Sanandaj, Iran
E-mail: salahkamangar@yahoo.com.

Dr. Hosseinali LOTFALIZADEH
Department of Plant Protection, East-Azarbaijan Agricultural and Natural Resources Research Center, Agricultural Research, Education and Extension Organization (AREEO), Tabriz, Iran
E-mail: hlotfalizadeh@gmail.com

Tab. 1: The recorded species of Ichneumonidae and their known host from Iran that were known as parasitoids of *Tortrix viridana* in the world

Parasitoid name	Known host in Iran	Distribution within Iran (province)	Reference (s)
Campopleginae *Campoplex tumidulus* GRAVENHORST, 1829	*Yponomeuta malinellus* ZEL. (Lep.: Yponomeutidae), *Ectomyelois ceratoniae* ZEL. (Lep:. Pyralidae)	Tehran, Qom and Markazi	(KISHANI FARAHANI et al. 2010, TALEBI et al. 2006)
Enytus apostata (GRAVENHORST, 1829)	*Lobesia botrana* (Lep.: Tortricidae)	West Azarbaijan	(AKBARZADEH-SHOUKAT 2012, MASNADI-YAZDINEJAD et al. 2010)
Cremastinae *Pristomerus armatus* (LUCAS, 1849)	------	Golestan and Mazandaran	(GHAHARI & JUSSILA 2010, 2011d, GHAHARI & JUSSILA 2011b)
Pristomerus vulnerator (PANZER, 1799)	*Lobesia botrana* (Lep.: Tortricidae)	West Azarbaijan	(AKBARZADEH-SHOUKAT 2012, MASNADI-YAZDINEJAD & JUSSILA 2009)
Cryptinae *Agrothreutes abbreviates* (FABRICIUS, 1794)	-----	Semnan	(GHAHARI 2012)
Gelis areator (PANZER, 1804)	-------	Isfahan	(BARAHOEI et al. 2015)
Gelis proximus (FORSTER, 1850)	--------	Golestan and Ardabuil	(BARAHOEI et al. 2012, GHAHARI & JUSSILA 2010)
Ichneumoninae *Diadromus varicolor* WESMAEL, 1845	------	West Azarbaijan	(KOLAROV & GHAHARI 2008)
Dirophanes invisor (THUNBERG, 1822)	--------	Gilan and West Azarbaijan	(GHAHARI & JUSSILA 2011a, KOLAROV & GHAHARI 2008)
Pimplinae *Endromopoda detrita* (HOLMGREN, 1860)	-------	Ardabil, Gilan, Golestan, Mazandaran, Tehran, West Azarbaijan	(GHAHARI & JUSSILA 2011c, MASNADI-YAZDINEJAD & JUSSILA 2008, MOHAMMADI-KHORAMABADI et al. 2013)
Ephialtes manifestator (LINNAEUS, 1758)	-------	Khorasan-Razavi, Mazandaran	(KOLAROV & GHAHARI 2006, MOHAMMADI-KHORAMABADI 2013)
Gregopimpla inquisitor (SCOPOLI, 1763)	---------	Tehran	(MASNADI-YAZDINEJAD & JUSSILA 2008)
Iseropus stercorator (FABRICIUS, 1793)	----------	Semnan and West Azarbaijan	(Ghahari 2012, Ghahari & Jussila 2011c)
Itoplectis alternans (GRAVENHORST, 1829)	*Lobesia botrana* (Lep.: Tortricidae)	Fars, Gilan and Mazandaran	(LOTFALIZADEH et al. 2012, MOHAMMADI-KHORAMABADI 2013)
Itoplectis maculator (FABRICIUS, 1775)	*Yponomeuta malinella* (Lep.: Yponomeutidae)	Tehran, West Azarbaijan	(KOLAROV & GHAHARI 2006, MOHAMMADI-KHORAMABADI et al. 2013)
Itoplectis tunetana (SCHMIEDEKNECHT, 1914)	*Yponomeuta malinella* (Lep.: Yponomeutidae), *Lobesia botrana* (Lep.: Tortricidae)	Alborz, Gilan, Kerman, Mazandaran, Ghazvin, Tehran, Sistan & Baluchestan, West-Azarbaijan	(AKBARZADEH-SHOUKAT et al. 2008, BARAHOEI et al. 2013, KASPARYAN 1973, MOHAMMADI-KHORAMABADI 2013, MOHAMMADI-KHORAMABADI et al. 2013, MOHAMMADI-KHORAMABADI et al. 2014, RADJABI 2011)

Parasitoid name	Known host in Iran	Distribution within Iran (province)	Reference (s)
Pimpla contemplator (MÜLLER, 1776)	-----	Golestan, Sistan and Baluchistan	(BARAHOEI et al. 2013, KOLAROV & GHAHARI 2006)
Pimpla flavicoxis THOMSON, 1877	-----	Fars and Kerman	(MASNADI-YAZDINEJAD & JUSSILA 2008, MOHAMMADI-KHORAMABADI et al. 2014)
Pimpla rufipes (MILLER, 1759)	*Malacosoma castrense* (L.) (Lep.: Lasiocampidae)	Alborz, East Azarbaijan, Gilan, Golestan, Kerman, Mazandaran and West Azarbaijan	(KARIMPOUR & HORSTMANN 2007, KOLAROV & GHAHARI 2006, MASNADI-YAZDINEJAD & JUSSILA 2008, MOHAMMADI-KHORAMABADI 2013, MOHAMMADI-KHORAMABADI et al. 2013, MOHAMMADI-KHORAMABADI et al. 2014)
Pimpla turionellae (LINNAEUS, 1758)	*Yponomeuta malinella* (Lep.: Yponomeutidae) and *Ennomos quarcinaria* (HUF.) (Lep.: Geometridae)	East Azarbaijan, Mazandaran and Tehran	(BABAEI et al. 2012, KASPARYAN 1974, MOHAMMADI-KHORAMABADI 2013, RADJABI 2011)
Scambus brevicornis (GRAVENHORST, 1829)	-------	Kordistan	(KOLAROV & GHAHARI 2006)
Scambus calobatus (GRAVENHORST, 1829)	---------	East Azarbaijan, Mazandaran and Semnan	(GHAHARI 2012, MASNADI-YAZDINEJAD & JUSSILA 2008)
Theronia atalantae (PODA, 1761)	*Ennomos quarcinaria* (Lep.: Geometridae)	Chaharmahal&Bakhtiari and Mazandaran	(BABAEI et al. 2012, KOLAROV & GHAHARI 2006, MOHAMMADI-KHORAMABADI 2013)
Tromatobia ornata (GRAVENHORST, 1829)	-----	Gilan, Mazandaran, Ghazvin and Khorasan-e-Razavi	(BARAHOEI et al. 2012, MOHAMMADI-KHORAMABADI 2013, MOHAMMADI-KHORAMABADI et al. 2013)
Tryphoninae *Tryphon* (*Symboethus*) *heliophilus* GRAVENHORST, 1829	-------	Gilan	(GHAHARI & JUSSILA 2011d)